EASY$ TIP SHEETS

Energy Advice Saving Yukoners Money

Quick Links

Residential Hydronic Heating

A residential hydronic heating system is one that uses hot water to heat a house. This relatively complex kind of heating system has distinct advantages and disadvantages over other heating systems. Because of its complexity there are more decisions to be made when designing the system and, as with any other heating system, attention to detail is essential for ease of operation and maintenance over the life of the system.

How hydronic heating systems work

Water is first heated in a boiler by oil, electricity, propane or wood. The heated water is then circulated to a heat transfer device where it releases the heat to the floor, or baseboard heaters in your home, before returning to the boiler for re-heating.

Advantages

Even heat

Hydronic heating systems can provide more even heat than other systems. A steady supply of warm water through the heating unit results in a constant supply of heat to the home. Even when the circulating pump shuts off, the mass of water in the system will continue to emit heat until the water cools.

Space savers

A small volume of hot water will deliver the same amount of heat as a large

Goal and Summary

This Easy$ tip sheet describes the advantages and disadvantages, design considerations, and equipment required for hydronic heating systems.

- Pipe insulation

Distributing the water

- One-pipe series loop system
- One-pipe system with diverting tees
- Two-pipe direct return system
- Two-pipe reverse return system

Controlling the Temperature

- Space heating
- Space and water heating

Installation hints

Selection considerations

volume of warm air. Heating air, rather than water, requires ductwork many times larger than a water-filled pipe.

Zoning

Different sections, or zones, of the home can be kept at different temperatures. The boiler can be located almost anywhere, as long as protection against freezing is adequate.

Other uses

When properly equipped, the hydronic heating system can be used to heat domestic water (i.e. water for cooking, washing and bathing), and for a variety of heating purposes outside the home, including heating greenhouses and garages, and hot tubs.

Disadvantages

With the exception of fan-coil systems, residential hydronic systems cannot provide cooling, humidification, air filtration, or forced air circulation. Excessive heat gains, from sources such as sunlight through a window, can't be easily transferred from one area to another. As with any plumbing system, damage can result in the event of piping leaks.

Design alternatives

The design of a hydronic heating system is more complex than that of other systems, and can be more expensive to install than most other systems. A wide variety of heat distribution methods and equipment are available when choosing a hydronic heating system. Some of these choices include:

Baseboard convectors

This system consists of a length of pipe (usually copper) with attached "fins" (usually aluminum) that increase the surface area of the piping to improve heat transfer. You can buy them with or without a sheet metal cover. With the cover they are installed at a low level along a wall; without the cover they can be concealed in an architectural enclosure, recessed into floors or areas where they won't be subject to damage or corrosion.

Radiators

Radiators are large cast-iron units, usually only found in older buildings. They were designed to provide full heating capacity at a lower temperature than baseboard convectors. You should use caution with radiators, as they can overheat, creating a risk of burns to those who come in contact with them.

Cast-iron baseboard heaters

These low-profile heaters and radiators have a lower heat output and a substantially higher cost than baseboard convectors.

Hot water/forced air fan and coils

These are fans designed with one or more hot water coils, either in the same enclosure as the fan, or mounted separately in the distribution ductwork.

Kick-space heaters

Designed to be installed horizontally in the small (usually 10 cm (4 inches) high) space under kitchen cabinets or bathroom vanities, these are small fan-coil units.

Hydronic Radiant floor heating

These systems have hot water piping or tubing installed in or under the floor, allowing the warm floor to heat the room. To maintain comfort, the floor surface temperature should not exceed 29°C (85°F). For a detailed description of hydronic radiant floor heating see **http://www.cmhc-schl.gc.ca/en/co/renoho/refash/refash_010.cfm**

Equipment

Hydronic heating systems consist of the following main components.

Boiler

The boiler, or hot water generator, does not boil the water, but simply reheats it prior to it being pumped to the heat transfer units such as baseboard heaters, in-floor tubing, radiators, etc. Boilers are generally rated on input and/or output in British thermal units per hour (Btu/h), or in kilowatts (1 kW = 3,412 Btu/h). Boiler output should be adequate to offset building design heat loss, piping losses (if the pipes run through unheated space), plus any additional heating needs such as garages or hot tubs.

Circulating pump

The circulating pump is an electrically-driven pump that forces the water through the boiler and the piping system to the heat transfer devices and then back to the boiler. Some systems have more than one circulating pump in order to serve separate systems (e.g. domestic hot water), areas or zones of the home.

Zone valves

Rather than having separate pumps for different zones, one circulating pump may serve several zones, with each zone regulated by a zone valve controlled by its own thermostat. Most residential zone valves are electric and operate on 24-volt alternating current. Pneumatic valves and self-contained hydraulically activated thermostat/valve units are also available.

Expansion tank

Water expands when heated and contracts when cooled. The expansion tank is a reservoir for the change in volume.

Air elimination devices

Air in a hydronic system reduces heating performance. Several devices are used to remove air from the piping system and return it to the atmosphere. An air venting device should be installed at each high point in the system where air can gather.

Heat transfer devices

These may include radiators, baseboard convectors, fan-coil units, or radiant floors.

Heat exchangers

These devices transfer heat to water or, to an anti-freeze solution.

Mixing valve

Some systems or parts of systems (i.e. radiant floors) require cooler water than is supplied by the boiler. A mixing valve blends cooler return water with hot boiler water to obtain the system temperature required.

Controls

Standard low-voltage (24 V AC) or newer programmable electronic thermostats can be used to provide temperature control. Thermostats are usually connected to, and control, the zone valves. When the valve is fully open, an end switch on the zone valve turns on the boiler and circulating pump. There are two basic boiler control strategies: variable temperatures if the boiler is used for space heating only and constant temperature if the boiler is also used to heat water, swimming pools, or hot tubs. This second method is often referred to as a summer/winter hook-up.

Piping

Copper piping is used most commonly to distribute the hot water. If piping is embedded in a concrete slab it may be made of synthetic rubber or plastic.

Pipe insulation

To reduce heat loss and to ensure that heat is delivered to spaces where it is required, insulate pipes running through unheated areas, such as crawlspaces.

Distributing the water

There are four basic piping systems used in hydronic heating to distribute heated water throughout your home.

1. One-pipe series loop system

The simplest hydronic heating piping system is a single pipe that runs through a number of rooms, with heat transfer devices inserted in the system wherever needed. No individual room control is possible within a loop, as a valve anywhere in the loop regulates flow to all heating units. It is possible to divide the home into a number of zones, with each zone being a series loop serving rooms of similar purpose and exposure. For example, a series loop could serve two or more bedrooms on the same side of the house. As shown in *Figure 1*, a balancing valve should be used in each loop of this multi-loop system, even when thermostatically controlled zone valves are used. Each series loop circuit should be provided with shut-off valves and a drain valve in the boiler room for isolation in the event of leaks.

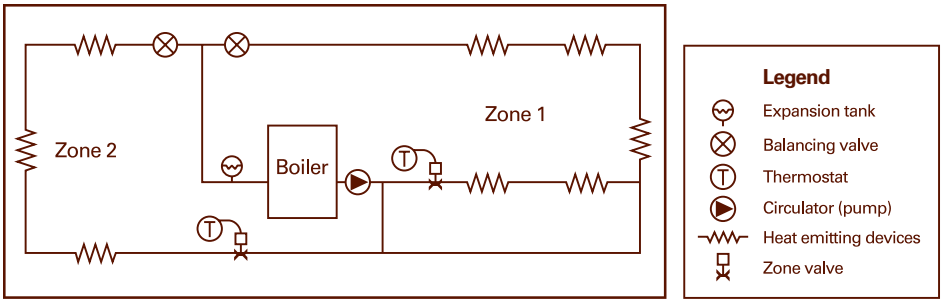

Figure 1. One-pipe series loop system
(Diagram credit: B.C. Hydro Power Smart Tip Sheet, *Hydronic Heating*)

2. One-pipe system with diverting tees

This system is similar to the series loop system in that a single pipe is used, but the heat transfer devices are installed in side circuits off the main pipe. A special pipe fitting, called a diverting or distributor tee, is installed in the piping to force the water to divert out of the main pipe through a branch containing the heating device, then back to the main piping loop. As shown in *Figure 2*, a balancing valve, or preferably a thermostatic control valve installed in each room, provides the individual control lacking in the series loop system. A similar result can be obtained by using ordinary tees and reducing the size of the by-pass piping. In the series loop and diverting tee systems, water temperature becomes progressively cooler as it passes through the successive heating units. These units must be selected accordingly. The living room should be served first, or from a separate loop, and the bedrooms served near the end of the loop. Otherwise you could have a bedroom that is too warm and a living room that is too cool.

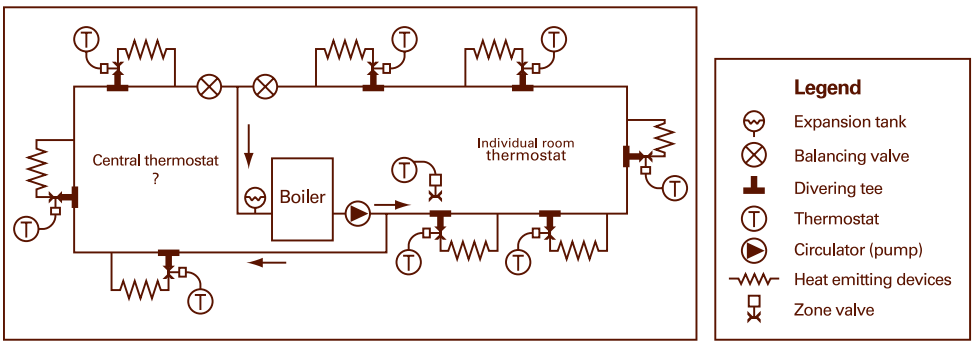

Figure 2. One pipe system with diverting tees
(Diagram credit: B.C. Hydro Power Smart Tip Sheet, *Hydronic Heating*)

3. Two-pipe direct return system

Two-pipe systems result in the same water temperature to all heating units, making balancing and temperature control easy. These systems are more expensive but provide the best temperature control. *Figure 3* illustrates a two-pipe direct return system, which uses balancing valves to ensure adequate flow through all heating zones.

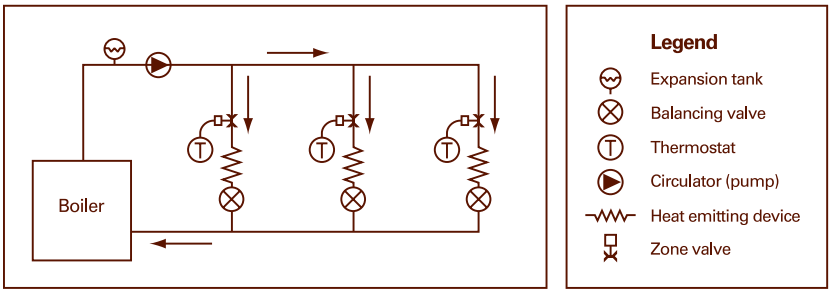

Figure 3. Two-pipe direct return system
(Diagram credit: B.C. Hydro Power Smart Tip Sheet, *Hydronic Heating*)

4. Two-pipe reverse return system

As shown in Figure 4, with a two-pipe reverse return system there is less need for balancing valves, as the total supply and return length is the same for all units, and the system tends to be inherently balanced.

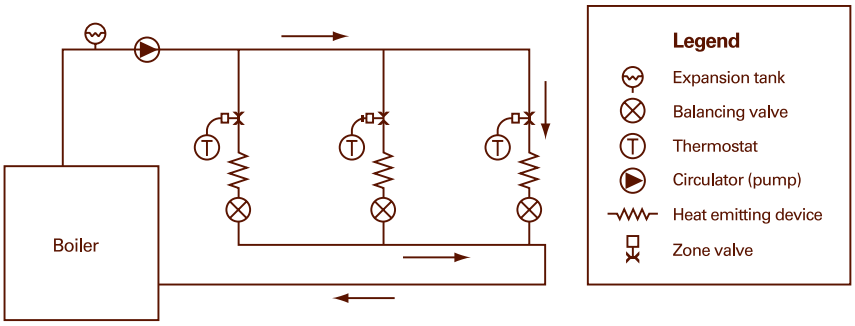

Figure 4. Two-pipe reverse return system
(Diagram credit: B.C. Hydro Power Smart Tip Sheet, *Hydronic Heating*)

Controlling the temperature

How you control your temperature depends on whether your hydronic heating is used only for space heating or both space and water heating.

Space heating

When a boiler is used for space heating, the simplest control strategy is to have the thermostat control the burner and circulating pump together. This adjusts the heating capacity to the heating needs and provides the lowest operating costs. A second method used residentially is to always keep the boiler hot and have the thermostat turn the circulator on and off. Operating costs may rise, however, through increased losses from escaped heat (stand-by losses). A third method is to continuously adjust the boiler temperature [minimum setting 50°C (122°F)] using an outdoor thermostat located in an area shielded from the sun. The room thermostat is then used to turn the zone valve on and off. This method, termed boiler water reset, is more energy-efficient than the single-temperature option.

Installation hints

A hydronically heated home can be made more comfortable by keeping in mind these suggestions.

Install some extra heat transfer capacity (e.g. a larger baseboard) in the bathrooms, as most people prefer bathrooms to be fairly warm.

Install a return air grille in the floor at the opposite side of the room from the heat transfer device to improve the removal of cold air off the floor and circulation over the heating element. Frequently cleaning the grille to remove collected dust and dirt will help keep air circulating properly.

Space and water heating

A combo system uses a gas or oil-fired domestic water heater for both space and domestic water heating. In operation, domestic hot water is drawn off to heat air in a fan-coil unit or to provide hot water for baseboard convectors or a radiant floor. The fan-coil units are designed to use the 60ºC (140ºF) hot water typically produced in a domestic water heater. Manufacturers of baseboard convectors can provide performance data for a similar operating temperature.

All the hot water piping and tubing, including the heat exchanger tubing, should comply with plumbing code requirements if they are subjected to the same temperatures and pressures as the domestic water supply system (i.e. use type K, L or M copper tube). With radiant floors, a water-to-water heat exchanger should be interposed between the domestic water and the floor heating water, as in most cases 60ºC (140ºF) water is too hot for floor heating.

Whenever the space heating side of the system is isolated from the domestic water side, an expansion tank is required on the space heating side, as it is now a closed system. As a closed system separated from domestic water pressure, the space heating side can be operated at a much lower system pressure. There are advantages to the isolated system and lower pressure; there is less strain on pipe and fittings, and in the event of a leak on the space heating side, there is only a limited amount of water, at relatively low pressure, to leak out. Special conditions prevail for combo systems. Check with the Yukon or City of Whitehorse building inspection departments for details.

If the house has been designed to energy efficiency standards such as R2000, the space heating load may not be much greater (and could even be less) than the domestic water heating load. In this case, the boiler could be sized for the larger of the two loads. A priority valve would direct most or all of the hot boiler water to the domestic water heater as needed. An energy-efficient house will not cool off appreciably during the relatively short time needed to reheat the domestic water tank, and as the boiler is not oversized for either space or domestic water heating needs, seasonal heating efficiency is not compromised.

An auxiliary coil can be connected to most boilers to heat domestic hot water in a separate tank.

Selection considerations

If you are thinking about installing a hydronic heating system in your home, consider the following:

How many zones do you want? A home should be zoned into areas according to function, usage, and outdoor and solar exposure.

As a minimum, bedrooms should be zoned separately from living/dining areas.

Rooms with a southern exposure should be zoned separately from rooms with other exposures, particularly when south-facing rooms have a large amount of glass.

Do you want a hydronic radiant floor heating system? Families with young children often prefer this system. The warm floors are enjoyed particularly in areas where heavy carpets and underlay aren't used.

Hydronic radiant floor heating systems have lower water temperature requirements than convection units and must be on separate zones.

This information is designed as a general guide. Please ensure that installations meet your requirements, manufacturers' instructions, and all applicable codes, standards and regulations.

This Easy$ tip sheet is provided by the Energy Solutions Centre.

If you have additional questions or comments, please contact the Energy Solutions Centre:

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